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I, LEANNE MYNOTT, ACTING MANAGER PATENT ADMINISTRATION hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ 1544 for a patent by MEAT & LIVESTOCK AUSTRALIA LIMITED filed on 09 July 1999.

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ACTING MANAGER PATENT
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AUSTRALIA

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ORIGINAL

PROVISIONAL SPECIFICATION

Title: IMAGE DATA ANALYSIS

Applicant: MEAT & LIVESTOCK AUSTRALIA LIMITED

The invention is described in the following statement:

IMAGE DATA ANALYSIS

This invention relates to image data analysis for objects such as meat carcases and meat cuts although the invention may also be applicable to other agricultural, mineral or manufactured objects.

In the meat industry, specialist trained and skilled operators are employed, in abattoirs for example, in order to inspect each animal carcase and to provide estimates or gradings of various parameters, such as the predicted saleable meat yield of each carcase, Such predictions of meat yield and gradings are very important for fixing a fair value for the carcase and for determining uses to which the carcase and meat cuts will be destined. Obviously it is very important for the meat industry generally including producers, processors and consumers that such operators are consistent both within a particular abattoir or processing facility and between different facilities at different place and different times.

There have been proposed and developed automated systems for image capture and colour analysis for automating yield predictions or gradings, or at least for providing some objective replacement or supplement to human operators. For predicting the meat yield of a carcase, yield equations have been developed by statistical methodologies such as multiple regression analysis, such yield equations using the colour data to provide estimates of meat yield. However, the results of such automated analysis and yield predictions have not been of acceptable reliability or at least have been capable of significant improvement.

It is an object of the present invention to provide a method of analysing colour image data relating to a target object to derive or predict more accurately and consistently a property of the object of which the colour is an indicator.

In the past, in order to predict the yield of meat carcase, i.e. the amount of saleable meat in the carcase, colour data captured by a colour video camera has been utilised in the form of R, G, and B values (red, green and blue values) in yield equations derived from

multiple field runs as described above. Particular care ought to be taken to ensure as far as possible that the R, G and B colour values are reliably and consistently measured both between different sites with different ambient conditions and using different cameras, and also throughout different periods of use, e.g. throughout a day, when lighting conditions can change. Our earlier patent application No. PCT/AU98/00135 (publication No. WO98/39627) provides considerable detail concerning calibration procedures and systems for achieving the reliable and consistent colour measurements.

However we have found that even accurate and repeatable measurements in the form of R, G and B values when utilised in the relevant yield equations can provide predicted yields which are still susceptible of significantly improved accuracy or consistency.

According to the present invention there is provided a method of analysing colour image data relating to a target object to derive or predict a property of the object of which colour is an indicator, the method including the step of processing the colour data to derive light intensity independent measures of colour values, followed by the step of calculating the property of the object utilising the light intensity independent colour measures in a predictive equation.

In the particular field of meat carcase yield prediction, the method includes the step of processing the colour data for a carcase to derive light intensity independent measures of colour values for the carcase, followed by the step of calculating the meat yield of the carcase utilising the light intensity independent colour measures in a yield predictive equation.

It will be convenient to further describe the invention in relation to the particular field for which the invention has been developed, namely beef carcase yield prediction and grading, however it is to be understood that the principles, methods and systems can be adapted to other field of use.

Intensity Normalised Colour Space

Considerable development of our beef carcase system ("BCS") for colour data capture and analysis has been towards achieving acceptable site-to-site consistency. We established that the existing methods of lighting distribution compensation on a plane did not adequately remove lighting variations in RGB space. To combat these variations, the present invention was developed involving use of an intensity normalised colour space. That is, the intensity component was removed from the measurements leaving only colour.

Intensity Normalised Components

The intensity normalised class CRiGiI has been adapted from the prior CRGB class consisting of Red, Green and Blue values. The class consists of the member variables Ri; Gi; and I; where Ri is the intensity normalised red value, Gi is the intensity normalised green value, and I is the intensity. The calculation of these variables is described below. The intensity variable I is only used for reconstruction of the RGB tuple and is not used in any yield equation calculations.

Calculation of RiGiI from RGB

The calculation of the intensity normalised values requires all red, green, and blue measurements of a RGB tuple. In addition, to ensure full intensity independence, a digitiser offset is preferably subtracted (since the offset associated with a digitiser for digitising measured RGB values in a colour data capture system is obviously not affected by light intensity variation.) Through use of an assigned offset value and supply of the RGB values, the intensity normalised values are found as follows:

$$R_i = \frac{(R-k)}{R+G+B-3k}$$

$$G_i = \frac{(G-k)}{R+G+B-3k}$$

$$I = \frac{(R+G+B-3k)}{3}$$

where k is the intensity normalised offset explained above.

Yield Equations

After the completion of numerous yield trials, we determined that to achieve acceptable levels of yield prediction accuracy, multiple yield equations may need to be developed for different animal types, even when considering beef carcases alone. Our final equations were based on both statistical methodologies and biological groupings. Six categories were finally selected. These are: Bulls, Cows, Light Grasslike, Heavy Grasslike, Light Grainlike, and Heavy Grainlike. "Light" and "Heavy" refer to carcase weight, and "Grasslike" and "Grainlike" refer to tissue colour. The selection of these equations and the methods for arriving at them are explained in the following sections.

Yield Equation Labels

As mentioned, the BCS yield prediction accuracy relies upon application of the appropriate yield equation from one of the six categories mentioned above. The values for the Wy and CompWy for a particular beef carcase side will therefore have been derived from the yield equations applicable to its category.

Wy = Predicted wholesale saleable meat yield

CompWy = Component predicted wholesale saleable meat yield for the BCS

Combined Equation Weightings

The BCS outputs not only its prediction of saleable meat yield, but also a yield that forms part of a combinatorial equation. This component yield (CompWy) is added to a

weighted CAS predicted yield representing the currently selected carcase type. "CAS" refers to a "Chiller Assessment System" (available from Viascan Quality Assessment, of Beenleigh, Queensland, Australia) which provides measures relating to meat yield after further analyses later in the processing operation in a chiller. This weighted addition must be applied off-line at the end of the day. The formula that is implemented is as follows:

Combined Wy = BCS_CompWy + k' x CAS_Wy

where k' is defined according to which carcase type has been selected. The appropriate values are shown below in the table. Note that the CAS yield equations exist for only three carcase categories. These are: bull, cow, and table beef (where the table beef category includes all beef from the four subcategories of the BCS).

BCS Yield Category	k'	CAS Yield Category
Bull	0.4627	Bull
Cow	0.8095	Cow
Light grain	0.6057	Table beef
Heavy grass	0.8136	Table beef
Light grass	0.7751	Table beef
Heavy grain	1	Table beef

Table: CAS yield weightings by category

The use of colour normalised colour values in yield equations has been found to provide more accurate and therefore more reliable yield predictions of beef carcases than measured colour values which are influenced by light intensity at the time and place of the image capture even if considerable measures have been taken to calibrate the equipment to remove equipment, site and time induced variables and even if considerable measures have been taken to provide controlled lighting conditions at the image capture station.

It is to be understood that various alterations, modifications and/or additions may be made to the features of the possible and preferred embodiment(s) of the invention as herein described without departing from the spirit and scope of the invention.

Dated this 9th day of July 1999

PATENT ATTORNEY SERVICES

Attorneys for

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